NOTES ON THE LIFE HISTORY, AND DESCRIPTIONS OF THE LARVA AND PUPA OF *NEOTYLOPTERUS PALLIDUS* (LECONTE) (COLEOPTERA: CURCULIONIDAE), A SEED PREDATOR OF *FORESTIERA ACUMINATA* (MICHX.) POIR. (OLEACEAE).

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Abstract

Larvae of *Neotylopterus pallidus* develop in seeds of *Forestiera acuminata,* 1 larva per seed, then exit from the fruits and pupate in the soil beneath the host plant. Rates of emergence of larvae from dry fruits and from fruits found in water beneath *F. acuminata* trees and kept in water are compared. Larvae remained in fruits as long as the fruits were kept in water, but began to emerge soon after the fruits were permitted to dry. Analysis of morphological characters of larvae and pupae indicates that *Neotylopterus* is properly placed in the subfamily Tychiinae, and should not be assigned to Anthonominae, as has been previously done.

Introduction

The genus *Neotylopterus* Hustache was assigned, along with *Lignyodes* Dejean, *Chionanthobius* Pierce, *Hamaba* Casey, *Plocetes* LeConte, and *Rosella* Whitehead, to the tribe Lignyodini of the curculionid subfamily Tychiinae by Clark *et al.* (1977). Little or nothing is known about the biology of most of these weevils. The sites of larval development have been recorded for a few species. The larvae of *Chionanthobius schwarzi* Pierce develop in seeds of the fringe tree, *Chionanthus virginicus* L. (Oleaceae) (Pierce 1912); *Lignyodes bischoffi* (Blatchley) and *L. helvola* (LeConte) larvae develop in seeds of *Fraxinus americana* L. (Oleaceae) (Barger and Davidson 1967); larvae of *Rosella sickingiae* Whitehead feed on seeds of *Sickingia maxonii* (Rubiaceae) (Janzen and Wilson 1977); and larvae of *Neotylopterus pallidus* (LeConte) were reported from fruits of *Forestiera acuminata* (Michx.) Poir. (Oleaceae) (Pierce 1916). The immature stages of members of these genera have not been described (see Burke and Anderson 1976). The purposes of this paper are to present further information on the life history of *N. pallidus* and to describe the full-grown larva and pupa of this rather striking, infrequently collected weevil (see Clark *et al.* 1977 for illustrations of the adult). This information will be analysed, along with information on other lignyodines, in a future study of phylogenetic relationships of taxa within Lignyodini.

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Natural History

Forestiera acuminata, the swamp-privet, is a dioecious shrub or small tree which occurs along streams and in swamps from eastern Texas to Georgia and South Carolina and as far north as southern Illinois and Indiana (Preston 1966). Pierce (1916) observed *N. pallidus* on *F. acuminata* at Victoria, Texas, and Blatchley and Leng (1916) stated that the weevil occurs in Posey County, Indiana, and St. Louis, Missouri. The Indiana and Texas records, respectively, appear to be at or near the northern and southern distributional limits of *F. acuminata,* and the weevil may be expected to have a range more or less coextensive with that of the plant.

Adult *N. pallidus* on *F. acuminata* were observed during May of 1975 on the flood plain at the intersection of Highway 30 and the Navasota River in Brazos County, Texas. Female plants in this area were in early to mid fruiting stages on 3 May. On that date a few *N. pallidus* adults were found on the female plants, but no weevils were ever found on male trees. A few fruits taken the same day were placed in a small cardboard box. Weevil larvae began to emerge from these fruits four days later, and continued to emerge for another 13 days. Examination of fruits (single-seeded drupes) revealed weevil larvae feeding within each of several seeds, never more than 1 larva per seed. Under natural conditions larvae apparently pupate, as reported by Pierce (1916), in the soil beneath the plants.

On 16 May a few more adult weevils were collected from the Navasota River Bottom on *F. acuminata* plants, which by then were in mid to late fruiting stages of development. Several hundred fruits were collected at that time. Some were taken directly from the trees, others from beneath some of the trees. At that time the ground beneath the trees was covered by water about 1 foot deep, and several mature fruits which had fallen from the trees were found floating on the surface of the water.

The fruits taken from the trees and those taken from the water beneath the trees were kept in separate lots. The ones from the trees were placed on a screen over a large porcelain pan. Some of those from the water beneath the trees were allowed to dry, then these were placed on another screen over another porcelain pan. The remaining fruits from the water beneath the trees were kept in water in a 3rd porcelain pan. Most of these sank to the bottom of the pan within a day.

In a few days weevil larvae began to emerge from both lots of dried fruits on screens. As they emerged they fell through the screens into the pans. The pans were checked periodically, emergent larvae transferred to wide-mouthed jars filled with a slightly moistened substrate consisting of ca. 2 parts peat moss and 1 part sand. The larvae, in continuous motion from the moment they emerged from the fruits, immediately began to tunnel head-first into the substrate. In a few days some of these, observed through the sides of the glass jars, had formed pupal cells like those described by Clark and Burke (1977) for the weevil *Tychius sordidus* LeConte. Pupae were observed in the cells a few days later.

The fruits placed in water in the 3rd pan were left there and observed for 2 weeks. During this time no weevil larvae emerged from these fruits, although larvae were emerging from the dry fruits over the 1st and 2nd pans at a rate of several per day during the same period. At the beginning of the 3rd week the fruits in water were removed and allowed to dry. As they dried,

weevil larvae began to emerge in numbers comparable to those observed emerging from the dried fruits.

Under natural conditions it is unlikely that the weevil larvae leave the fruits before the fruits have matured and fallen to the ground (the fruits are deciduous; none was found on the trees in mid-summer). This would account for the presence of larvae in fruits found beneath the trees. The observed reluctance of larvae to emerge from fruits held in water probably indicates that larvae receive no stimulus to exit from the fruits until favorable, i.e., relatively dry, conditions prevail. Wet conditions like those observed on the day the *F. acuminata* fruits were collected are common in the spring on the flood plain where the weevils and their hosts live. In fact, the *F. acuminata* plants prefer low areas where standing water remains after floods recede.

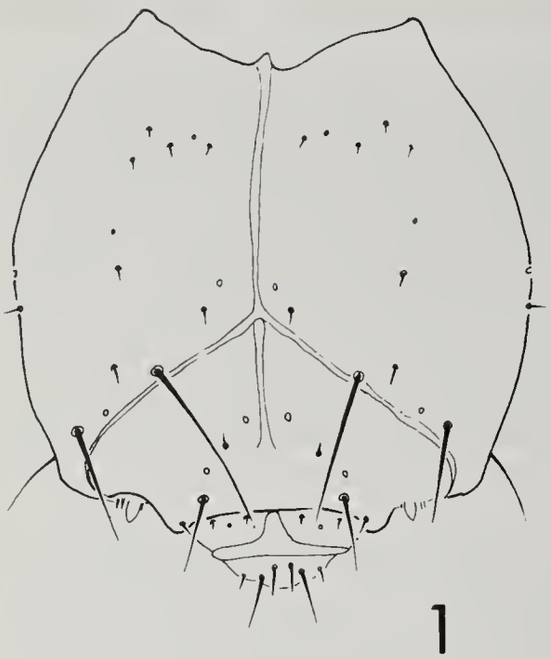
Larvae continued to emerge from the fruits collected on 16 May for about 15 days. These were placed on the sand-peat moss substrate. The jar in which the live larvae were placed was kept indoors through the following winter. Adults of *N. pallidus* began to emerge from the pupal cells during November of 1975, and adults continued to emerge through January of the following year.

A few days after larvae stopped emerging, the rate of infestation of collected fruits was determined by opening the fruits and checking for presence of larvae or of emergence holes and larval feeding cavities within the seeds. Of 503 *F. acuminata* fruits taken directly from the trees, 57 (11.3%) were infested. Of 100 fruits found beneath the trees and kept in water, 16 (16%) were infested. As noted, fruits kept in water sank to the bottom of the pan within a day. Fruits which fell from the trees prior to the time of observation were probably under water, and therefore passed over when the other fruits were gathered. Infested fruits probably ripen and fall earlier than healthy ones, so it is not unlikely that the fruits missed were more heavily infested than the ones collected. The rate of infestation of fruits found in water beneath the trees but not kept in water was not determined. Larvae had already emerged from 35 (61%) of the 57 infested fruits taken directly from the trees at the time they were examined; the remaining 22 (39%) infested fruits still contained live larvae. By contrast, 11 (69%) of the infested fruits kept in water still contained larvae when examined, probably a reflection of the delay imposed upon the larvae by the wet conditions.

The weevils apparently complete only 1 generation per year. The number of larval instars was not determined. No parasites were reared from the larvae, which seems unusual in view of the relatively large number of larvae reared through to the adult stage. No provision was made to capture parasites which might have emerged before the larvae were placed in the sand-peat moss filled jars. However, parasites were collected in large numbers from larvae of other tychiines after the larvae had formed pupal cells in the same kind of substrate (Clark and Burke 1977).

Descriptions of Full-Grown Larva and Pupa

About 100 larvae recovered from the *F. acuminata* fruits collected 16 May, 1975 were examined. Three of these were mounted on slides. One pupa recovered from the sand-peat moss substrate in November, 1975 was also examined. The identity of these immatures as *N. pallidus* was confirmed by their association with the reared adults. Terms used to describe larval setae



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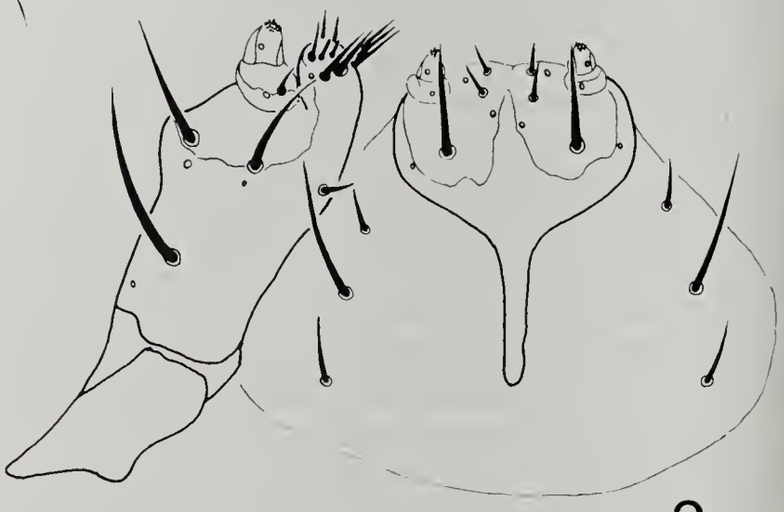

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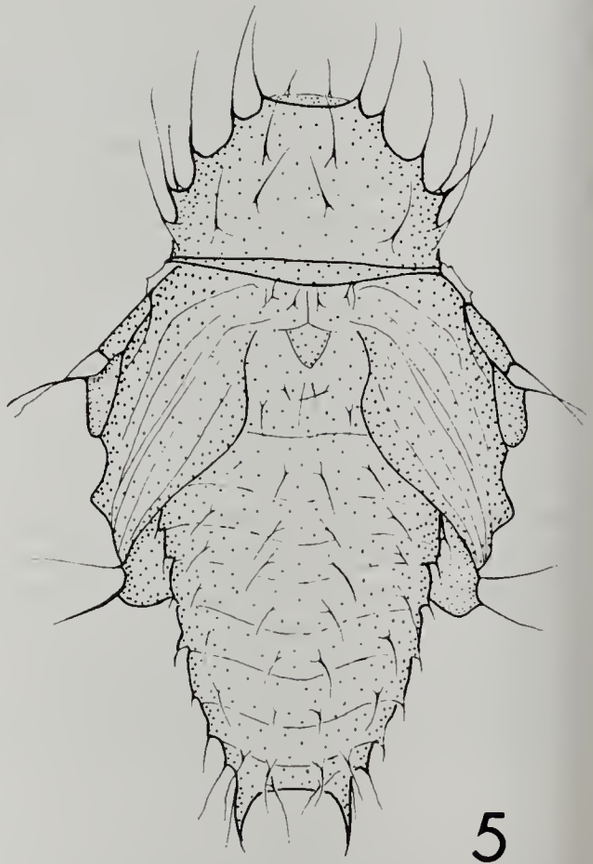

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Figs. 1-5. Larva and pupa of *N. pallidus*: 1, dorsal view of head capsule of larva; 2, larval epipharynx; 3, ventral view of labium and left maxilla of larva; 4, dorsal view of pupa; 5, ventral view of pupa.

and other structures are those proposed by Anderson (1947). Where applicable, terms for pupal setae follow Burke (1968).

Larva (figs. 1-3). Body robust, strongly curved; 4.16-5.16 mm long (15 larvae); creamy white; surface smooth; dorsum of pronotum slightly sclerotized.

Head capsule (fig. 1) slightly wider than long, sides evenly rounded; truncate or slightly emarginate posteriorly, uniformly light orange brown; width 0.64-0.82 mm (11 larvae, av. 0.72mm). Anterior ocellar areas each with small lens and small spot of subcutaneous pigment; posterior ocellar areas without lenses and without pigment. Antenna with 3 long, pointed sensory processes, and 3 shorter processes; accessory appendage conical, blunt. Endocarina more than 1/2 length of frons. Frontal sutures distinct throughout length. Frontal setae 1 and 2 absent; seta 3 minute; seta 4 long; seta 5 minute. Frontal sensilla: 1 pair present between frontal setae 3 and 4, another pair present posterior to seta 3. Dorsal epicranial setae 1, 2, and 3 minute, setae 4 and 5 long; 1 pair of sensilla between setae 3 and 5, another pair posterior to seta 1. Posterior epicranium with 4 pairs of minute setae and 2 pairs of sensilla. Lateral epicranial seta 1 minute, seta 2 long; 1 pair of sensilla posterior to seta 1. Ventral epicranial setae 1 and 2 short. Clypeus with 2 minute setae and 1 sensillum on each side. Labral seta 1 long; seta 2 longer than 1; seta 3 short; lateral labral sensilla and median labral sensillum present. Epipharynx (fig. 2): labral rods stout, widely separated; 2 or 3 broad, acuminate, anterolateral setae present on each side; 6 broad, acuminate, anteromedian setae present, outer pair narrower and shorter than median pairs; 4 median spines present; 6 pairs of sensory pores present, these arranged in 2 clusters. Mandible stout, with 2 apical teeth; mandibular seta 1 moderately long, seta 2 short; 1 sensillum present. Maxillary palpus (fig. 3) consists of 2 articles; basal article with 1 long seta and 2 sensilla, apical article with 1 sensillum only. Dorsal malar area with 3 long, pointed setae, 2 shorter, blunt setae, and 1 sensillum; ventral malar area with 6 setae, basal member longest. Stipes: setae 1, 3, and 4 long; seta 2 minute; 3 sensilla present. Labial palpus (fig. 3) consists of 2 articles; basal and apical articles each with 1 sensillum, without setae; glossa with 2 pairs of minute setae and 2 sensilla; post-mental seta 1 short, seta 2 long, seta 3 shorter than 1.

Pronotum with 4 long setae and 8 short to minute setae. Thoracic spiracle bicameral; air tubes longer than peritreme, each with 4 or 5 distinct annuli. Prodorsum of mesothorax and that of metathorax with 1 short seta. Postdorsum of mesothorax and that of metathorax with 4 setae, setae 1 and 3 minute, 2 and 4 long. Alar area of each thoracic segment with 1 minute seta. Spiracular area of each thoracic segment with 1 minute seta. Pleural fold of prothorax with 2 setae, seta 1 short, seta 2 long; pleural folds of mesothorax and of metathorax each with 1 long seta. Epipleural fold of each thoracic segment with 1 long seta. Pedal area of each segment with 1 long seta, several short to minute setae, and a few sensilla. Sternal area of each thoracic segment with 1 short seta.

Abdomen with 8 pairs of bicameral spiracles; air tubes and annuli as in thoracic spiracle. Abdominal segments 1-7 each with 3 dorsal folds; prodorsum of each segment with 1 short seta; postdorsum of each segment with 5 setae, setae 1, 3 and 4 minute, setae 2 and 5 long; spiracular areas each with 1 short seta and 1 minute seta; epipleural areas each with 1 long seta and 1 short seta; pedal areas each with 1 short seta; eusternal areas each with 2 short setae and with several longitudinal rows of acute asperities. Sternellum present. Anus terminal.

Pupa (figs. 4-5). Body elongate; conspicuously clothed with long setae; length of 1 pupa 4.33 mm.

Head and rostrum: 1 pair of long, attenuate frontal setae present; each seta borne on summit of small tubercle. One pair of attenuate supraorbital setae present; these shorter and more slender than frontal setae, borne on smaller tubercles. One pair of long, attenuate, interocular setae present; these borne on moderately large tubercles located medially on inner edge of each eye case; tubercles separated by distance much less than length of a basirostral seta. One pair of distirostral setae present; each seta borne of small tubercle; tubercles separated from each other by

distance slightly less than distance separating basirostral setae. One pair of basirostral setae present.

Pronotum bearing long, slightly curved setae, each borne on summit of moderately large to large tubercle. One pair of anteromedian setae and 1 pair of median setae; each seta borne on moderately large tubercle; median setae slightly more widely separated than anteromedian setae. One pair of widely separated posteromedian setae; these slightly shorter than anteromedian and median setae. Two pairs of long anterolateral setae. Four pairs of posterolateral setae; median 2 posterolateral setae on each side borne separately on large tubercles which lie adjacent to each other, 1 ventral to the other; posteriormost pair of posterolateral setae borne on large tubercles located 1 on each side of pronotum dorsal to median pairs of posterolateral setae.

Mesothorax and metathorax each with 2 pairs of setae, each seta borne on small tubercle; metanotal setae longer than mesonotal setae.

Abdomen: each of segments 1-7 bearing 2 pairs of long, slender, discotergal setae; segment 8 with only 1 pair of discotergal setae; each discotergal seta borne on moderately large tubercle. Each of segments 1-8 with a single laterotergal seta on each side; laterotergal setae of segment 8 much longer than those of segments 1-7. Ninth abdominal segment bearing 1 pair of long, slender, inwardly curved, widely separated attenuate processes. One long seta borne lateroventrally on each side of 9th segment basad of each apical process. Sterna devoid of setae.

Femora each bearing a long preapical seta and a long apical seta; each seta borne on small tubercle; preapical setae branched.

Discussion

Kissinger (1964) assigned *Neotylopterus* to the tribe Endaeini of the subfamily Anthonominae. Burke (1973, 1976), however, gave reasons for excluding Endaeini from Anthonominae. Clark *et al.* (1977) reevaluated the composition of the group and assigned most of the North American genera to various tribes of Tychiinae. *Neotylopterus* was assigned to the tribe Lignyodini.

It is appropriate, therefore, that the immatures of *N. pallidus* be compared with those of present Anthonominae and of other Tychiinae. Larvae of several species of Anthonominae were described by Ahmad and Burke (1972), pupae by Burke (1968). The only tychiines whose immatures have been described in sufficient detail to make meaningful comparisons are members of the genus *Tychius* (Clark *et al.* 1978) and a single member of the genus *Sibinia* (Rogers *et al.* 1975).

The larva and pupa of *N. pallidus* are distinguished from known *Tychius* and *Sibinia* larvae and pupae by the character states listed in table 1. In addition, the larva of *Neotylopterus* has 5, instead of 4 abdominal postdorsal setae. The pupa of *N. pallidus* also differs from known *Tychius* and *Sibinia* pupae in having much longer setae throughout and much longer posterior processes on abdominal segment 9.

Ahmad and Burke (1972) listed 3 characteristics as diagnostic of larvae of members of the tribe Anthonomini (= Anthonominae): (1) most abdominal segments with 3 dorsal folds; (2) frontal seta 2 absent; and (3) anus subterminal. *N. pallidus* agrees with the anthonomines in (1) and (2) (it also lacks frontal seta 1), but like known *Tychius* and *Sibinia* larvae, it has a terminal anus. Burke (1968) was unable to determine definitive diagnostic characteristics of pupae of the anthonomines because of lack of knowledge about pupae of related weevil groups, but suggested some possible characters for this purpose. The pupa of *N. pallidus* differs from known antho-

nomine pupae in possession of femoral setae, and in the short 9th abdominal segment which has long, widely separated posterior processes. *N. pallidus* shares these features with known *Tychius* and *Sibinia* pupae (table 1). In addition, there are slight differences in numbers and relative lengths of setae. The terminal anus of *Neotylopterus* larvae as opposed to the subterminal anus of anthonomine larvae, and the differences in the structure of the 9th abdominal segment of the pupa seem to be good indications that *Neotylopterus* is not an anthonomine.

No character states clearly apomorphic in Tychiinae are apparent from

TABLE 1. Larval and pupal characters in *Neotylopterus pallidus*, *Tychius* spp[1]., and *Sibinia sulcatula*[2].

Character	Character state		
LARVAE	*N. pallidus*	*Tychius* spp.	*S. sulcatula*
Frontal seta 4	short	long	long
Dorsal epicranial seta 1	short	long[3]	short
Median labral sensillum	present	present[4]	absent
Epipharyngeal sensory pores	3	2	3
Apical teeth of mandible	2	2	3
Mandibular setae	1 long, 1 short	2 long	1 long, 1 short
Labium, ventral malar area	6 setae	5 setae	5 setae
Labium, dorsal malar area	5 setae	4 setae[5]	4 setae
Maxillary palpus, sensilla	2	2	1
Thoracic pedal areas	1 long seta	3 long setae	3 long setae
Pronotum	4 long setae	5 long setae[6]	6 long setae
Thoracic sternal setae	short	long	long
Thoracic spiracle	bicameral	bicameral	unicameral
Abdominal spiracles	bicameral	unicameral	unicameral
Abdominal prodorsal setae	short	long	short
Abdominal pedal and eusternal setae	short	long	long
Abdominal spiracular seta 2	short	long	short
PUPAE			
Posterolateral setae of pronotum	4 pairs	2 pairs	4 pairs
Femoral setae	2	1 or 2	2

[1]From Clark *et al.* (1978)
[2]From Rogers *et al.* (1975)
[3]Short in *T. picirostris* (Fabr.)
[4]Absent in *T. picirostris* (Fabr.)
[5]3 in *T. stephensi* Schönh. and *T. picirostris* (Fabr.)
[6]6 in *T. stephensi* Schönh. and *T. picirostris* (Fabr.)

the present study. Further study of the immatures of more weevil taxa is needed before these can be cited as evidence for the hypothesis of monophyly of the subfamily as presently constituted. Likewise, immatures of more of the lignyodines, as well as of members of the other tychiine tribes must be compared before these can be used to determine relationships within the subfamily. In addition to the *Tychius* and *Sibinia* larvae and pupae already referred to, larvae and pupae of several other species of *Sibinia* are currently under study, and larvae of members of other tychiine genera, including *Lignyodes* Dejean, *Chionanthobius* Pierce, *Elleschus* Stephens, and *Ochyromera* Pascoe have been secured and will be described in the future.

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